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MARKING METHODS FOR IMPROVING AERIAL APPLICATION OF FOREST PESTICIDES

by

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ABSTRACT

Markers that are readily visible to the pilot are essential for proper identification of the boundaries of treatment areas and spacing of application swaths. They increase accuracy, efficiency, and safety of aerial application of pesticides and other materials.

Methods for placing marking panels in the treetops are described. The slingshot and crossbow methods are satisfactory for marking trees under 100 feet (30.48 m) in height. The line-throwing gun can be used for marking trees up to about 150 feet (45.72 m) tall and possibly taller, depending mainly on the load of power charges, ballistics of missile, weight of line, and firing angle. Helium-inflated balloons, protruding above the forest canopy, also are useful navigational aids. Other marking methods are also described and reviewed.

KEYWORDS: Pesticide application methods, spraying (aerial).

INTRODUCTION

The accuracy, efficiency, and safety of such aerial applications as insecticides, herbicides, and fertilizers depend mainly on the aids available to the pilot for identifying boundaries of areas to receive treatments and gaging application swaths. Visible markers prevent accidental treatment of sensitive areas and minimize overdosage and underdosage caused by irregular spacing of swaths. The result is greater effectiveness of treatments and lower dosages.

The pilot must see at least two markers simultaneously for proper alinement of the aircraft path. Most agricultural ground markers would be impractical or unsatisfactory under forest conditions by being obscured by trees or topographic features and not visible from the air on oblique approaches.

Most information on methods of marking areas of forests for aerial application of pesticides is scattered, unpublished, and not readily available, either for field experiments or for operational use. There is a need to bring the information together so that the user can select the most desirable method for his specific needs.

The purpose of this paper is to describe some published and unpublished methods for placing colored markers in and above the treetops so that they are readily visible from the air under mountainous forest conditions.

LITERATURE REVIEW

Several methods have been used for placing markers on the trees from the ground. Eaton and others[1] marked corners of plots and midpoints of long boundaries to be sprayed with white wind socks or white canvas bags stuffed with brush and tied to the tops of trees. They did not mention how the wind socks and bags were placed on or above the trees. I assume that they were attached to long poles and placed in treetops by climbing the trees. Helium-inflated balloons, attached to high-speed reels, were used as swath markers. Some problems were encountered because the balloons were fragile, easily punctured, and difficult to carry through dense undergrowth.

Eaton et al. (1949) reported marking plot corners, where suitable openings occur, with large wooden or rock crosses on the ground. Also, trees, 100-140 feet (30.48-42.67 m) high, were marked with paint bombs and cloth streamers. A line-throwing gun was used to shoot a line over the tree to be marked. Aluminum paint bombs, containing detonator and dynamite, were hoisted by line and electrically detonated from the ground. The explosive force scattered the paint through the upper crowns. A similar method was used to hoist streamers into treetops.

Maksymiuk and others,[2] using the line-throwing principle, developed a simple and rapid method for placing colored plastic panels into treetops with the aid of a slingshot to mark boundaries of plots to be sprayed. Helium-inflated balloons, protected by light, plastic drycleaning bags, were effectively used to mark swath spacings.

Wickman[3] used a target long bow with a 29-inch (73.66-cm) arrows and

[1]C. B. Eaton, H. A. Jaynes, and J. M. Muiry. Experiments with airplane applications of DDT for spruce budworm control. Forest Insect Laboratory, Beltsville, Maryland. Progress Report, 26 p. 1949.

[2]Bohdan Maksymiuk, P. A. Boving, R. D. Orchard, and R. G. Winterfeld. Forest tests to develop an operational method to control the Douglas-fir tussock moth with a polyhedrosis virus. USDA Forest Service and Agricultural Research Service. Progress Report, 33 p. 1968.

[3]Boyd E. Wickman, Forestry Sciences Laboratory, Corvallis, Oregon, personal communication, 1975.

monofilament fishing line to place half muslin bedsheets on the treetops--40-70 feet (12.19-21.34 m) high--as markers for aerial photography. On the average, a two-man crew took 29 minutes to place marker with target bow in the treetop compared with 32.5 minutes by climbing. A target bow is underpowered for most field needs. The more powerful crossbow is better for marking taller trees--60-100 feet (18.29-30.48 m) high--and causes less fatigue than a target bow (USDA Forest Service 1974).

Collis and Harris (1973) used a .45-caliber line-throwing gun to hoist a cutter into trees for obtaining samples of branches. Hurtig and others[4] reported firing smoke-puff shells directly overhead which burst above treetop level, releasing brown smoke. This method, in combination with radio ground to air communication, enabled the pilot to line up accurately for each successive spray run.

Wear and Howard[5] described in detail two methods for marking the treetops from the air. The treetops were painted by the pilot or passenger from a hovering helicopter about 6 feet (1.83-m) above a tree and along one side of it. Fluorescent paint was sprayed from a pressurized tank using a 7-foot (2.13 m) long lightweight spray wand with a shutoff valve. A 2-foot(0.61-m) pipe with two spray nozzles was attached to the end of the wand.

The second method involved a crepe-paper streamer that spread into a treetop. It was thrown by hand from a helicopter flying at low speed--10-15 miles per hour (16.09-24.14 km/h). The marker consisted of four to six crepe-paper strips--5 inches by 5 feet (12.70 cm by 1.52 m)--attached about 8 inches (20.32 cm) apart along a 6-foot (1.83-m) string. A heavy metal washer was attached to each end of the string. The paper strips were accordion-folded into a 5- by 5-inch (12.70- by 12.70-cm) stack (fig. 1C). The marker was placed in the tree crown by holding one washer and crepe paper packet between thumb and forefinger, the other washer between the third and fourth finger, and throwing the packet assembly laterally at the treetop. R. D. Orchard (Aerial Applications Research Work Unit, Forestry Sciences Laboratory, Corvallis, Oregon) successfully used this method to mark trees from a helicopter. Impregnated cloth or plastic was satisfactory. Orange fluorescent streamers were more visible than other colors.

These two methods are especially suitable for marking trees rapidly in inaccessible large areas. However, these aerial methods may require previous ground identification of trees to be marked (or radio communication with ground crew) and are somewhat limited because of safety factors and displacement of marking materials by wind.

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[4]H. Hurtig, J. J. Fettes, A. P. Randall, and W. W. Hopewell. A field investigation of the relation between the amount of DDT spray deposited, the physical properties of the spray and its toxicity to larvae of the spruce budworm. Defense Research Board, Department of National Defense, Canada, Suffield Experimental Station, Ralston, Alberta. Suffield Report No. 176, Part 6, 141 p. 1953.

[5]J. F. Wear and Benton Howard. New tree marking system improves forest spraying operation. Pacific Northwest Region, USDA Forest Service, Portland, Oregon. Unpublished report, 8 p. 1966.

Figure 1.--Streamer assembly for marking trees from the air: A, Partially accordion-folded streamers attached to string with washers at other end of string; B, unfolded streamers; C, accordion-folded packet for field use.

PLACING MARKERS IN TREETOPS BY SLINGSHOT, CROSSBOW, AND LINE-THROWING GUN

General principle and procedures are similar for placing markers on the treetops by slingshot, crossbow, and line-throwing gun. Various methods and materials were investigated. Only tested materials showing satisfactory performance are given below.[6] The following materials are needed:

[6]Mention of products and companies by name does not constitute endorsement by the U.S. Department of Agriculture, nor does it imply approval of a product to the exclusion of others which may also be suitable.

1. Propellants

   (a) Wrist-Rocket® hunting and target slingshot (Wrist Rocket Mfg. Co., Inc., Columbus, Nebr.).

   (b) 80-lb (36.29-kg) thrust Power master® crossbow (Wham-O-Mfg. Co., Inc., San Gabriel, Calif.).

   (c) Marine E-Z Liner (line-throwing gun) with shoulder stock (Scientific Products Corp., 426 Swann Ave., Alexandria, Va.).

2. Projectiles

   (a) Fishing sinkers (elliptical and round) weighing 3-4 ounces (85-113 g), preferably sprayed with orange fluorescent paint to increase visibility.

   (b) Crossbow weighted bolts (a metal rod--3.5 by 0.25 inches (8.89 by 0.64 cm)--taped to the point of the bolt).

   (c) Soft plastic missiles, 5 by 3 inches (12.70 by 7.62 cm) (orange color), and hard metal missiles, 5 by 1 inches (12.70 by 2.54 cm) (orange color).

3. Line

   Nylon monofilament fishing lines--18- to 25-pound (8.17- to 11.34-kg) test--on spool for attaching projectiles to be fired.

4. Markers

   Light-reflecting yellow, white, and fire-orange plastic marking panels--18 by 60 inches (45.72 by 152.40 cm)--are cut from either 18 or 36 inches wide (45.72 or 91.44 cm), 300 feet long (91.44 m) rolls (Bergman Banner Co., 1822 Steiner St., San Francisco, Calif.). Holes are punched in two diagonally opposite corners of each panel with an eyelet punch and are reinforced with strong tape and brass eyelets. These holes are used for attachment of monofilament lines.

The slingshot and crossbow are available in most sporting good stores. The line-throwing gun with missiles can be obtained from marine dealers or directly from the manufacturer. The cost for the slingshot at time of purchase was under $5, crossbow under $60, and line-throwing gun under $160.

The basic steps for a two-man crew are:

1. Crewmember No. 1 attaches projectile (sinker for slingshot, bolt for crossbow, missile for the line-throwing gun) to the monofilament line (firing line) and catapults it over the treetop (fig. 2--A, B, C), letting the weight of the projectile pull the line down.

2. Crewmember No. 2 removes the projectile, ties the firing line firmly to one corner of the marking panel (fig. 2D) through the reinforced hole in the panel, and ties a second monofilament line (guide line) in the same way to the diagonally opposite corner of the panel.

3. Crewmember No. 1 hoists the marker onto the treetop by pulling on the firing line, and crewmember No. 2 assists in positioning the marker on the treetops (fig. 2E) by using the guide line. Crewmen cut both lines and tie them to the trees high enough to prevent accidental dislocation by animals. Colored flagging is attached to the lines for ease in locating them later. After aerial application, marking panels can be removed for reuse by cutting one line and pulling the second line.

Observations

Recently, R. D. Orchard, M. J. Haskett, and Drs. John Neisess and G. P. Markin of the research work unit on aerial application and others used slingshot, crossbow, and line-throwing methods for marking trees for aerial application of insecticides. Personal preference for a particular method varied. In general, the following can be concluded:

Figure 2.--Marking trees from the ground: Projectiles (sinker, bolt, missile) attached to the monofilament line are catapulted over the treetop with the slingshot (A), crossbow (B), and line-throwing gun (C); projectile is removed and the line attached to the marking panel (D); hoisted panel is shown in treetop (E); a pair of captive helium-inflated balloons (F) can be seen above the treetops (in shadow of the helicopter).

1. Slingshot method is preferable for marking trees under 60 feet (18.29 m) tall; however, this method can be used for placing markers on trees up to 100 feet (30.48 m) in height. Sinkers sprayed with an orange fluorescent paint or tagged with a ribbon (see fig. 2A, arrow) helped to located the end of the line after it had been shot over the tree.

2. Crossbow method is satisfactory for placing markers on the intermediate trees--60-100 feet (18.29-30.48 m) high. A metal rod--3.5 by 0.25 inches (8.89 by 0.64 cm)--taped to the point of the bolt provided enough weight--about 2 ounces (57 g)--to pull the line to the ground.

3. Line-throwing gun method is suitable for placing markers on trees up to 150 feet (45.72 m) or taller, depending on the type of missile used (large plastic or small metal), the load of the power charges, weight of the line, firing angle, and wind resistance.

4. Both the line-throwing gun and crossbow methods have disadvantages compared with the slingshot method for marking short trees because of the excessive power (bolts and missiles overshoot treetops). This can be remedied sometimes by shooting bolts or missiles from a steep slope, if available, well below the tree to be marked. During high wind, the crossbow bolt should be shot upwind into the top of the tree to be marked.

5. Marking panels should be placed in the treetops, by the line-throwing method, only a few days before aerial application. This will reduce the chance of markers sliding down from the treetops. All markers should be checked the day before spraying and pulled back to the treetops if loose or displaced. If marker is on one side of the tree and cannot be readily visible to the pilot, a second marker can be placed on the other side of the same tree. Orange and red panels were more visible than other colors.

Caution. The slingshot, crossbow, and line-throwing gun can be dangerous if used carelessly. Detailed instructions for operation, maintenance, and safety are provided by the manufacturers. All equipment should be inspected for proper and safe functioning. Shooting range should be clear of people. Pulling the line to retrieve projectiles stuck in the tree branches is dangerous; instead, the line should be cut and the projectile will usually drop to the ground in the predetermined spot.

PLACING HELIUM-INFLATED BALLOONS AND PANELS ABOVE THE TREETOPS

Helium-inflated balloons and panels can be used for marking boundaries of spray areas and swaths.

Captive balloon method.--The following materials are needed:

1. Balloons. Brightly colored balloons were purchased in novelty stores. Stronger and larger meteorological balloons, weighing 0.70 ounce (20 g), were also used (Weather Measure Corp., P.O. Box 41257, Sacramento, Calif.).

2. Helium. Portable helium cylinders with the regulator valve.

3. Line. Lightweight string or monofilament line, 5- to 8-pound (2.27- to 3.63-kg) test, wound on spools.

4. Bags. Lightweight plastic dry-cleaning garment bags.

5. Weights. Heavy fishing sinkers, 10 to 20 ounces (283 to 567 g).

6. Reel. Commercial or homemade reel or spool for storing line.

The following procedure is used:

1. Inflate balloons with helium, tie with a string, attach line, and test for leaks and lift capability. If the lift is insufficient, use more helium or a lighter line, or preferably use two balloons in tandem attached to one line. Slip lightweight plastic drycleaning bag over balloons.
2. Release balloons until they are above the treetops and fasten the line to heavy sinker or other object on the ground. Balloons can also be used to indicate desired height for spraying at low wind velocities (fig. 2F).

Pulling balloons down after each swath run prevents accidental retreatment of the same area (see footnote 2). This captive balloon method was satisfactory for temporary markers for spray swaths in conjunction with the panel markers on the treetops indicating plot boundaries. Balloons should be kept away from sharp objects, sun, and oil sprays; I recommend two balloons inside a lightweight plastic drycleaning bag for increasing the lift and lifespan of the balloons. They should be inflated and placed in the bags shortly before aerial application

Elevated-pole and flag method.--The following materials are needed:

1. Panels. Colored plastic or cloth panels or streamers can be used.
2. Poles. Long, lightweight poles (single, multiple, or telescoping).

The following procedure is used:

1. Attach flag, panel, or streamer firmly to the end of pole.
2. Climb the tree and pull up the pole by rope.
3. Elevate pole with marker above the treetop to the desired height and tie it with a rope to the tree.
4. Climb down and inspect the marker.

Elevated-pole and flag method is especially satisfactory for marking trees that can be climbed safely. Advantage of this method is that trees can be marked well in advance of aerial application. Markers are not displaced by wind.

OTHER METHODS

Below are several marking methods that offer some potential.

Smoke

Smoke-generating devices mounted on spray or guide aircraft can be used especially for marking swaths for treatment in large and inaccessible forest areas. Ground smoke-generating devices (smoke bombs, Ben Meadows Co., 553 Amsterdam Ave., N.E., Atlanta, Ga.) can be used in large forest openings. These methods are simple; however, smoke behavior and displacement can be adversely affected by airmass movement.

Flares

Aerial signal cartridges (SFR-2) ejected by a small pengun (Penguin Industries, Inc., P.O. Box 98, Parkersburg, Pa.; Ben Meadows Co.) can be used as temporary or emergency markers in areas where there is little fire hazard (swamps, lakes). According to the manufacturers, flare can ascend to about 350 feet (106.7 m) and burn with a brilliant red light of about 12,000 candlepower for 6-9 seconds. Other colors are available.

Special Balloons

Helium-inflated large balloons, such as Kytoon® (W. R. Grace & Co., 62 Whittmore Ave., Cambridge, Mass.) can be useful navigational markers in open terrain. However, their use as markers in forestry is limited because of the large amount of helium needed, maneuverability, and high cost.

Moving Flagman

This method can be used satisfactorily for indicating swath spacings during aerial applications in the open forest or on rangeland. This method usually involves one person on each side of application plot, holding a flag on a handle. Both flagmen move a predetermined distance (swath width) and signal the pilot. Flagmen should avoid inhaling pesticides and exposure to descending pesticides by staying upwind and wearing protective devices and clothing.

Automatic Flagman

An automatic flagman, a pilot-operated aircraft tagging system (Air-Ag., Inc., Route 4, City-County Airport, Walla Walla, Wash.) offers promise for certain forest and rangeland applications. Weighted paper streamers are ejected from the dispenser mounted on either fixed- or rotary-wing aircraft. During the spraying of sagebrush, it was found that the automatic flagman could not replace a moving flagman because many markers fell between clumps of brush and were not readily visible to the pilot (USDA Forest Service 1969). A similar situation was observed under forest conditions by Drs. G. P. Markin and John Neisess (Forestry Sciences Laboratory, Corvallis, Oreg.).

Placing colored markers in the openings on the ground or on the top of vegetation is a satisfactory method of indicating where herbicide should be applied for release of small conifers from dense brush.[7]

Electronic Aids

Aircraft equipped with electronic aids, such as a Decca Navigator System, offer potential for large aircraft treating extensive, flat areas (Underwood 1971, International Agricultural Aviation Centre 1973). However, these developments in avionics have not yet found practical application in forestry in the United States because of cost and complexity of the equipment and treatment of the small, mountainous areas common in forestry.

CONCLUSIONS

User can select any method (or combination of methods) or modify it according to his specific field needs. The described marking methods proved satisfactory during aerial applications of insecticides under variable forest conditions. They can also be used for some aerial applications of herbicides and fertilizers.

The slingshot and crossbow methods are satisfactory for marking trees under 100 feet (30.48 m) in height. The line-throwing gun can be used for marking trees up to 150 feet (45.72 m) or taller, depending on the load of power charges, firing angle, weights of projectile and monofilament line, and other factors. Light-reflective plastic marking panels were superior to cloth panels due to visibility and no snagging problems in pulling them through the crowns into the treetops. They were visible for at least 1 mile. Orange, yellow, and red markers were preferred to other colors by the pilots. An average of about 20 minutes, with a two-man crew, was necessary for placing marker into treetop with slingshot, crossbow, or line-throwing gun.

Captive helium-inflated balloons and elevated poles and flags protruding above the forest canopy can be useful navigational aids. Well-identified boundaries of areas for treatment and swath spacings can result in more productive flying time, less fatigue to pilots, safety, and more accurate and efficient aerial application of pesticides.

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[7]Dr. R. E. Stewart, Forestry Sciences Laboratory, Corvallis, Oregon, personal communication, 1975.

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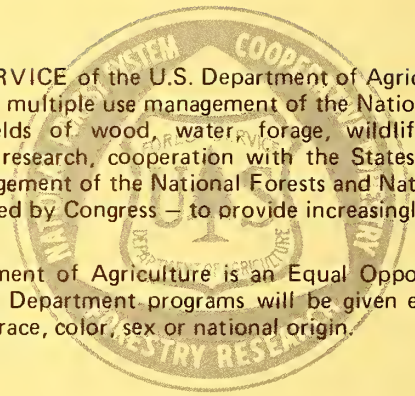

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